

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

WHAT IS CLAIMED IS:

1. A method for determining a protection path for a failure event link in an optical network of a set of nodes interconnected by a set of links, the method comprising:

5 receiving a set of link metrics corresponding to wavelength reservations for a set of protected links on a set of protection path links;

10 calculating a set of widths using the set of link metrics, each width corresponding to a capacity of a protection path link to protect the failure event link;

15 calculating a protection path including protection path links for the failure event link using the set of widths.

20 2. The method of Claim 1, wherein a width of a protection path link is a normalized difference between a maximum wavelength reservation on the protection path link and a wavelength reservation on the protection path link for the failure event link.

25 3. The method of Claim 2, wherein calculating a protection path further comprises:

determining a set of possible protection paths;

25 determining a protection path maximum width for the set of possible protection paths; and

selecting a protection path from the set of possible protection paths using the protection path maximum width.

30 4. The method of Claim 3, wherein determining a protection path maximum width further comprises:

determining a set of possible protection path widths from the set of possible protection paths; and

35 selecting a maximum possible protection path width from the set of possible protection path widths.

1 41914/FLC/F179-01-00075 FLA

5. The method of Claim 4, wherein the width of a possible protection path is a minimum of widths of the protection path
5 links included in the possible protection path.

10 6. The method of Claim 3, wherein the protection path maximum width is a minimum width of the protection path links included in the possible protection paths.

15 7. The method of Claim 3 wherein selecting a protection path from the set of possible protection paths further comprises randomly selecting a protection path if the protection path maximum width is greater than zero.

20 8. The method of Claim 3 wherein selecting a protection path from the set of possible protection paths further comprises:

determining the number of protection path links of zero width included in each possible protection path; and

25 selecting the possible protection path with the fewest number of protection path links of zero width.

9. A method for establishing a protected working path from a source node to a terminal node in an optical network of a set of nodes interconnected by a set of links, the method comprising:

30 determining by the source node a working path including a set of working path nodes and a set of working path links;

transmitting to a first working path node from the source node a setup message including the protected working path;

35 determining a working path link linking the source node and the first working path node;

receiving a set of link metrics corresponding to wavelength reservations for a set of protected links on a set of protection path links;

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

5 calculating a set of widths using the set of link metrics, each width corresponding to a capacity of a protection path link to protect the working path link;

calculating a protection path including protection path links for the working path link using the set of widths.

10 10. The method of Claim 9, wherein a width of a protection path link is a normalized difference between a maximum wavelength reservation on the protection path link and the wavelength reservation on the protection path link for the working path link.

15 11. The method of Claim 10, wherein calculating a protection path further comprises:

determining a set of possible protection paths;

20 determining a protection path maximum width for the set of possible protection paths; and

selecting a protection path from the set of possible protection paths using the protection path maximum width.

25 12. The method of Claim 11, wherein determining the protection path maximum width further comprises:

determining a possible protection path width for each of the possible protection paths in the set of possible protection paths; and

selecting a maximum possible protection path width.

30 13. The method of Claim 12, wherein the width of a possible protection path is a minimum of widths of the protection path links included in the possible protection path.

1 41914/FLC/F179-01-00075 FLA

5 14. The method of Claim 11, wherein determining the protection path maximum width further comprises determining a minimum width of the protection path links included in the possible protection paths.

10 15. The method of Claim 11, wherein selecting a protection path from the set of possible protection paths further comprises randomly selecting a protection path from the set of possible protection paths if the protection path maximum width is greater than zero.

15 16. The method of Claim 11 wherein selecting a protection path from the set of possible protection paths further comprises:

determining the number of protection path links of zero width included in each possible protection path; and

selecting the possible protection path with the fewest number of protection path links of zero width.

20 17. A method for establishing a protected working path from a source node to a terminal node in an optical network of a set of nodes interconnected by a set of links, the method comprising:

25 receiving by a node from a prior node a first setup message including a working path including a set of working path nodes and a set of working path links;

transmitting to a working path node from the node a second setup message including the protected working path;

determining a working path link linking the node and the working path node;

30 receiving a set of link metrics corresponding to wavelength reservations for a set of protected links on a set of protection path links;

35 calculating a set of widths using the set of link metrics, each width corresponding to a capacity of a protection path link to protect the working path link;

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

5 calculating a protection path including protection path
links for the working path link using the set of widths.

10 18. The method of Claim 17, wherein a width of a protection path
link is a normalized difference between a maximum wavelength
reservation on the protection path link and the wavelength
reservation on the protection path link for the working path
link.

15 19. The method of Claim 18, wherein calculating a protection
path further comprises:

20 determining a set of possible protection paths;
determining a protection path maximum width for the set
of possible protection paths; and
selecting a protection path from the set of possible
protection paths using the protection path maximum width.

25 20. The method of Claim 19, wherein determining the protection
path maximum width further comprises:

25 determining a possible protection path width for each
of the possible protection paths in the set of possible
protection paths; and
selecting a maximum possible protection path width.

30 21. The method of Claim 20, wherein the width of a possible
protection path is a minimum of widths of the protection path
links included in the possible protection path.

35 22. The method of Claim 19, wherein determining the protection
path maximum width further comprises determining a minimum width
of the protection path links included in the possible protection
paths.

1 41914/FLC/F179-01-00075 FLA

23. The method of Claim 19, wherein selecting a protection path
from the set of possible protection paths further comprises
5 randomly selecting a protection path from the set of possible
protection paths if the protection path maximum width is greater
than zero.

24. The method of Claim 19, wherein selecting a protection path
10 from the set of possible protection paths further comprises:

determining the number of protection path links of zero
width included in each possible protection path; and

selecting the possible protection path with the fewest
number of protection path links of zero width.

15 25. A data processing system adapted to determine a protection
path for a failure event link in an optical network of a set of
nodes interconnected by a set of links, comprising:
20

a processor; and

25 20 a memory operably coupled to the processor and having
program instructions stored therein, the processor being
operable to execute the program instructions, the program
instructions including:

25 25 receiving a set of link metrics corresponding to
wavelength reservations for a set of protected links on
a set of protection path links;

30 calculating a set of widths using the set of link
metrics, each width corresponding to a capacity of a
protection path link to protect the failure event link;

30 calculating a protection path including protection
path links for the failure event link using the set of
widths.

35

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

26. The data processing system of Claim 25, wherein a width of
a protection path link is a normalized difference between a
5 maximum wavelength reservation on the protection path link and a
wavelength reservation on the protection path link for the
failure event link.

27. The data processing system of Claim 26, wherein the program
10 instructions for calculating a protection path further include:

determining a set of possible protection paths;
determining a protection path maximum width for the set
of possible protection paths; and
15 selecting a protection path from the set of possible
protection paths using the protection path maximum width.

28. The data processing system of Claim 27, wherein the program
instructions for determining a protection path maximum width
further include:

determining a set of possible protection path widths
from the set of possible protection paths; and
selecting a maximum possible protection path width from
the set of possible protection path widths.

25 29. The data processing system of Claim 28, wherein the width of
a possible protection path is a minimum of widths of the
protection path links included in the possible protection path.

30 30. The data processing system of Claim 27, wherein the
protection path maximum width is a minimum width of the
protection path links included in the possible protection paths.

1 41914/FLC/F179-01-00075 FLA

5 31. The data processing system of Claim 27, wherein the program instructions for selecting a protection path from the set of possible protection paths further include randomly selecting a protection path if the protection path maximum width is greater than zero.

10 32. The data processing system of Claim 27, wherein the program instructions for selecting a protection path from the set of possible protection paths further include:

determining the number of protection path links of zero width included in each possible protection path; and

selecting the possible protection path with the fewest number of protection path links of zero width.

15 33. A data processing system adapted to establish a protected working path from a source node to a terminal node in an optical network of a set of nodes interconnected by a set of links, comprising:

a processor; and

a memory operably coupled to the processor and having program instructions stored therein, the processor being operable to execute the program instructions, the program instructions including:

determining by the source node a working path including a set of working path nodes and a set of working path links;

transmitting to a first working path node from the source node a setup message including the protected working path;

determining a working path link linking the source node and the first working path node;

receiving a set of link metrics corresponding to

30
35

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

wavelength reservations for a set of protected links on
a set of protection path links;

5 calculating a set of widths using the set of link
metrics, each width corresponding to a capacity of a
protection path link to protect the working path link;

10 calculating a protection path including protection
path links for the working path link using the set of
widths.

34. The data processing system of Claim 33, wherein a width of
a protection path link is a normalized difference between a
maximum wavelength reservation on the protection path link and
the wavelength reservation on the protection path link for the
working path link.

35. The data processing system of Claim 34, wherein the program
instructions for calculating a protection path further include:

20 determining a set of possible protection paths;
determining a protection path maximum width for the set
of possible protection paths; and
selecting a protection path from the set of possible
protection paths using the protection path maximum width.

25 36. The data processing system of Claim 35, wherein the program
instructions for determining the protection path maximum width
further include:

30 determining a possible protection path width for each
of the possible protection paths in the set of possible
protection paths; and

selecting a maximum possible protection path width.

1 41914/FLC/F179-01-00075 FLA

37. The data processing system of Claim 36, wherein the width of
a possible protection path is a minimum of widths of the
5 protection path links included in the possible protection path.

38. The data processing system of Claim 35, wherein the program
instructions for determining the protection path maximum width
further include determining a minimum width of the protection
10 path links included in the possible protection paths.

39. The data processing system of Claim 35, wherein the program
instructions for selecting a protection path from the set of
possible protection paths further include randomly selecting a
15 protection path from the set of possible protection paths if the
protection path maximum width is greater than zero.

40. The data processing system of Claim 35, wherein the program
instructions for selecting a protection path from the set of
possible protection paths further include:
20

determining the number of protection path links of zero
width included in each possible protection path; and

selecting the possible protection path with the fewest
25 number of protection path links of zero width.

41. A data processing system adapted to establish a protected
working path from a source node to a terminal node in an optical
network of a set of nodes interconnected by a set of links,
comprising:
30

a processor; and

a memory operably coupled to the processor and having
program instructions stored therein, the processor being
operable to execute the program instructions, the program
instructions including:
35

1 41914/FLC/F179-01-00075 FLA

5 receiving by a node from a prior node a first setup message including a working path including a set of working path nodes and a set of working path links;

transmitting to a working path node from the node a second setup message including the protected working path;

10 determining a working path link linking the node and the working path node;

receiving a set of link metrics corresponding to wavelength reservations for a set of protected links on a set of protection path links;

15 calculating a set of widths using the set of link metrics, each width corresponding to a capacity of a protection path link to protect the working path link;

20 calculating a protection path including protection path links for the working path link using the set of widths.

25 42. The data processing system of Claim 41, wherein a width of a protection path link is a normalized difference between a maximum wavelength reservation on the protection path link and the wavelength reservation on the protection path link for the working path link.

43. The data processing system of Claim 42, wherein the program instructions for calculating a protection path further include:

30 determining a set of possible protection paths;

determining a protection path maximum width for the set of possible protection paths; and

35 selecting a protection path from the set of possible protection paths using the protection path maximum width.

35

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

44. The data processing system of Claim 43, wherein the program
instructions for determining the protection path maximum width
5 further include:

determining a possible protection path width for each
of the possible protection paths in the set of possible
protection paths; and

selecting a maximum possible protection path width.

10

45. The data processing system of Claim 44, wherein the width of
a possible protection path is a minimum of widths of the
protection path links included in the possible protection path.

15 46. The data processing system of Claim 43, wherein the program
instructions for determining the protection path maximum width
further include determining a minimum width of the protection
path links included in the possible protection paths.

20 47. The data processing system of Claim 43, wherein the program
instructions for selecting a protection path from the set of
possible protection paths further include randomly selecting a
protection path from the set of possible protection paths if the
protection path maximum width is greater than zero.

25 48. The data processing system of Claim 43, wherein the program
instructions for selecting a protection path from the set of
possible protection paths further include:

30 determining the number of protection path links of zero
width included in each possible protection path; and

selecting the possible protection path with the fewest
number of protection path links of zero width.

35

1 41914/FLC/F179-01-00075 FLA

49. A computer-readable storage medium embodying computer program instructions for execution by a computer, the computer
5 program instructions adapting a computer to determine a protection path for a failure event link in an optical network of a set of nodes interconnected by a set of links, the computer instructions comprising:

10 receiving a set of link metrics corresponding to wavelength reservations for a set of protected links on a set of protection path links;

calculating a set of widths using the set of link metrics, each width corresponding to a capacity of a protection path link to protect the failure event link;

15 calculating a protection path including protection path links for the failure event link using the set of widths.

50. The computer-readable storage medium of Claim 49, wherein a width of a protection path link is a normalized difference between a maximum wavelength reservation on the protection path link and a wavelength reservation on the protection path link for the failure event link.

51. The computer-readable storage medium of Claim 50, wherein the program instructions for calculating a protection path further comprise:

determining a set of possible protection paths;

20 determining a protection path maximum width for the set of possible protection paths; and

30 selecting a protection path from the set of possible protection paths using the protection path maximum width.

52. The computer-readable storage medium of Claim 51, wherein the program instructions for determining a protection path maximum width further comprise:

1 41914/FLC/F179-01-00075 FLA

5 determining a set of possible protection path widths
from the set of possible protection paths; and

selecting a maximum possible protection path width from
the set of possible protection path widths.

10 53. The computer-readable storage medium of Claim 52, wherein
the width of a possible protection path is a minimum of widths of
the protection path links included in the possible protection
path.

15 54. The computer-readable storage medium of Claim 52, wherein
the protection path maximum width is a minimum width of the
protection path links included in the possible protection paths.

20 55. The computer-readable storage medium of Claim 51, wherein
the program instructions for selecting a protection path from the
set of possible protection paths further comprise randomly
selecting a protection path if the protection path maximum width
is greater than zero.

25 56. The computer-readable storage medium of Claim 51, wherein
the program instructions for selecting a protection path from the
set of possible protection paths further comprise:

determining the number of protection path links of zero
width included in each possible protection path; and

selecting the possible protection path with the fewest
number of protection path links of zero width.

30 57. A method for establishing a protected working path from a
source node to a terminal node in an optical network of a set of
nodes interconnected by a set of links, the method comprising:

35 determining by the source node a working path including
a set of working path nodes and a set of working path links;

1 41914/FLC/F179-01-00075 FLA

5 transmitting to a first working path node from the source node a setup message including the protected working path;

determining a working path link linking the source node and the first working path node;

10 receiving a set of wavelength reservations for a set of protected links on a set of protection path links;

15 calculating a set of a normalized differences between a maximum wavelength reservation on a protection path link and a wavelength reservation on the protection path link for the working path link;

20 determining a set of possible protection paths for the working path link;

25 determining a set of possible protection path widths from the set of possible protection paths;

 selecting a maximum possible protection path width from the set of possible protection path widths;

 if the number of possible protection paths is greater than one and the possible protection path maximum width is greater than zero then randomly selecting a protection path;

 if the number of possible protection paths is greater than one and the protection path maximum width is equal to zero then performing the following:

 determining the number of protection path links of zero width included in each possible protection path; and

 selecting the possible protection path with the fewest number of protection path links of zero width; and

 if the number of possible protection paths is equal to one then selecting the one possible protection path.

1 41914/FLC/F179-01-00075 FLA

58. A data processing system adapted to establish a protected working path from a source node to a terminal node in an optical network of a set of nodes interconnected by a set of links, comprising:

10 a processor; and
a memory operably coupled to the processor and having program instructions stored therein, the processor being operable to execute the program instructions, the program instructions including:

15 determining by the source node a working path including a set of working path nodes and a set of working path links;

20 transmitting to a first working path node from the source node a setup message including the protected working path;

25 determining a working path link linking the source node and the first working path node;

30 receiving a set of wavelength reservations for a set of protected links on a set of protection path links;

35 calculating a set of a normalized differences between a maximum wavelength reservation on a protection path link and a wavelength reservation on the protection path link for the working path link;

determining a set of possible protection paths for the working path link;

selecting a maximum possible protection path width from the set of possible protection path widths;

if the number of possible protection paths is greater than one and the possible protection path

35

March 17, 2001

1 41914/FLC/F179-01-00075 FLA

maximum width is greater than zero then randomly selecting a protection path;

5 if the number of possible protection paths is greater than one and the protection path maximum width is equal to zero then performing the following:

10 determining the number of protection path links of zero width included in each possible protection path; and

selecting the possible protection path with the fewest number of protection path links of zero width; and

15 if the number of possible protection paths is equal to one then selecting the one possible protection path.

20
25

30

35